Faculty of Resource Science and Technology

Distribution and Source of Hydrocarbons in Marine Sediments from Exclusive Economic Zone (EEZ) off Sarawak, Malaysia.

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DECLARATION

I declare the work in this thesis was carried out in accordance with the regulations of University Malaysia Sarawak. The thesis is orginal and it is the result of my work, unless otherwise indicated or acknowledged as reference work. The thesis has not been accepted for any degree and is not currently submitted in candidature for any other degree.

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ABSTRACT

The concentration and sources of aliphatic hydrocarbons and polycyclic aromatic hydrocarbons (PAHs) in surface and core sediments from Sarawak Exclusive Economic Zone (EEZ) were investigated. Aliphatic hydrocarbons concentrations in surface sediments ranged between 2.8-744.4 µg/g. The highest concentration of total aliphatic hydrocarbons (TAHs) was detected in surface sediment of ST02 (Kuching Waters) with 744.4 µg/g. Concentration of aliphatic hydrocarbons in core sediments ranged between 7.0-123.7, 122.6-324.4 and 8.05-46.6 µg/g of ST01, ST02 and ST03, respectively. The sources of aliphatic hydrocarbons in sediments of Sarawak EEZ were originated from mixture of anthropogenic and biogenic sources as indicated by alkane biomarker indices. Fresh oil input has been detected in sediments at several sites of Sarawak EEZ whereas old petroleum contamination also being observed as indicated by presence of unresolved complex mixture (UCM) and hydrocarbon biomakers (hopane and sterane). Concentrations of PAHs in surface sediments of Sarawak EEZ ranged 8.56-374.7 ng/g. Several sites at Sarawak EEZ were moderately polluted by PAHs but the PAHs concentrations did not pose biological adverse effects because not exceeded the effect range low (ERL) and effect range medium (ERM). Isomeric PAHs ratios were employed to determine sources of PAHs in sediments from Sarawak EEZ. The main source of PAHs in surface sediments of Sarawak EEZ as indicated by Principal Component Analysis (PCA) was pyrogenic. The dominance of high molecular weight (4,5 and 6 ring) PAHs in surface sediments of Sarawak EEZ were correlated with silt and clay fractions. Concentrations of PAHs in core sediments of ST01, ST02 and ST03 were 13.6-92.5, 37.2-151.2 and 24.3-72.9 ng/g, respectively. The presence of unweathered fresh petroleum source was detected in core sediment of ST01. PAHs origin in core sediment of

ST02 were believed from mixture of pyrogenic and petrogenic with minor input of pyrolytic PAHs. Source of PAHs in core sediment of ST03 was mainly derived from combustion (pyrogenic).

Keywords: Aliphatic hydrocarbons; polycyclic aromatic hydrocarbons (PAHs), heavy metals, sediments; Sarawak Exclusive Economic Zone (EEZ).

Taburan dan Sumber Hidrokarbon dalam
Enapan Marin dari Zon Ekonomi Eksklusif Sarawak, Malaysia

ABSTRAK

Kepekatan dan sumber hidrokarbon alifatik dan hirokarbon aromatic polisiklik (HAP) dalam sedimen permukaan dan sedimen teras dari Zon Eksklusif Ekonomi (ZEE) Sarawak telah dikaji. Kepekatan hidrokarbon alifatik dalam sedimen permukaan adalah dalam 2.8-744.4 µg/g dengan kepekatan total hidrokarbon alifatik tertinggi dikesan dalam sedimen permukaan ST02 (Perairan Kuching) dengan 744.4 µg/g. Kepekatan hidrokarbon alifatik dalam sedimen teras masing-masing adalah dalam julat 7.0-123.7, 122.6-324.4 dan 8.05-46.6 ug/g di ST01, ST02 dan ST03. Sumber hidrokarbon alifatik dalam sedimen dari ZEE Sarawak adalah berasal dari campuran antropogenik dan biogenik seperti yang ditunjukkan oleh index penanda biologi alkana. Input minyak yang baru telah dikesan dalam sedimen pada beberapa tempat di ZEE Sarawak manakala pencemaran minyak lama juga diperhatikan seperti ditunjukkan oleh kehadiran campuran kompleks tidak terurai dan penanda biologi hidrokarbon (hopana dan sterana). Kepekatan HAP dalam sedimen permukan ZEE Sarawak adalah dalam julat 8.56-374.7 ng/g. Beberapa lokasi pensamplem di ZEE Sarawak adalah sederhana tercemar oleh HAP tetapi kepekatan HAP tidak menyebabkan kesan buruk biologi kerana tidak melebihi kesan julat rendah dan kesan julat sederhana. Nisbah isomer HAP telah digunakan untuk mementukan sumber HAP dalam sedimen dari ZEE Sarawak. Sumber utama HAP dalam sedimen permukaan seperti ditunjukkan oleh Analisis Komponen Prinsipal (AKP) adalah sumber pirogenik. HAP dengan berat molekul tinggi (4, 5 dan 6 gelang) adalah dominan dalam sedimen permukaan di ZEE Sarawak dan berkorelasi dengan pecahan lodak dan tanah liat. Kepekatan HAP dalam sediment teras dari ST01, ST02 and ST03 masing-masing adalah dalam julat 13.6-

92.5, 37.2-151.2 and 24.3-72.9 ng/g. Kehadiran petroleum baru tidak terluluhawa telah dikesan dalam sedimen teras pada ST01. Sumber HAP dalam sedimen teras ST02 dipercayai dari campuran pirogenik dan petrogenik dengan input minor HAP pirolitik. Sumber HAP dalam sediment teras ST03 adalah datang dari pembakaran (pirogenik).

Kata kunci: *Hidrkarbon alifatik; hidrokarbon aromatik polisiklik; sedimen; Zon Eksklusif Ekonomi Sarawak.*

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LIST OF ABBREVIATIONS

ACL	Average Chain Length
B[a]A	Benzo[a]antharacene
B[b]F	Benzo[b]fluoranthene
B[ghi]P	Benzo[ghi]perylene
B[k]F	Benzo[k]fluoranthene
CPI	Carbon Preferences Index
DB[b]A	Dibenz[a,h]anthracene
EEZ	Economic Exclusive Zone
ERL	Effect Range Low
ERM	Effect Range Medium
GC-FID	Gas Chromatography-Flame Ionization Detector
GC-MS	Gas Chromatography-Mass Spectrometry
HMW	High Molecular Weight
I_{geo}	Geochemical Accumulation Index
IS	Internal Standard
LMW	Low Molecular Weight
m/z	Mass-to-Charge Ratio
PAHs	Polycyclic Aromatic Hydrocarbons
PCA	Principal Component Analysis
PEL	Probable Effect Limit
SEAFDEC	Southeast Asian Fisheries Development Center
SQGs	Sediment Quality Guidelines

TAH	Total Aliphatic Hydrocarbons
TAR	Terrigenous/Aquatic Ratio
TEL	Threshold Effect Limit
TOM	Total Organic Matter
UCM	Unresolved Complex Mixture
UNCLOS	United Nations Convention on the Law
US EPA	United States Environmental Protection Agency